Application for
UNITED STATES LETTERS PATENT

of

KIYOHIKO YAMAYA

for

PICKUP APPARATUS OF PIANO

PICKUP APPARATUS OF PIANO

BACKGROUND OF THE INVENTION:

1. Field of the Invention

The present invention relates to a pickup apparatus of a piano which is mounted to a piano for taking out piano sound as electric signal.

Since pianos have a history of some hundreds years and are loved on a worldwide basis, names of various parts of a piano are different depending upon countries,fanciers and makers in many cases. Therefore, it is necessary to define the names of various members of piano used in this specification.

The term "piano body (A)" used in this specification means both "grand piano" shown in Figures 1 and 2, and "vertical piano" shown in Figure 3. That is, the term "piano body (A)" is used for both the pianos.

The term "stationary member (B)" used in this specification generally means, as shown in Figures 1 to 3, cast-iron plate (b1), pin block (b2) for stopping an end of strung string, case (a1), brace (b4), inner rim (b5), outer rim (b6), back post (b3) of the vertical piano body (A), accessory thereof, and shape of the accessory.

The term "sound source member (C)" used in this specification generally means, as shown in Figures 1 to 3, sound board (c1) used in a general piano, rib (c2) adhered to the sound board (c1), bridge (c3) adhered

to the sound board, bridge pin (c4) of the bridge (c3) adhered to the sound board (c1), and string (c5) adhered to the sound board (c1) and strung such as to be in contact with the bridge (c3).

The term "pickup apparatus body (D)" used in this specification generally means sensor member (1) having first contact member (2) which is in contact with the stationary member (B) and second contact member (3) which is in contact with the sound source member (C) such as the sound board (c1) of the piano body (A).

2. **Description of the Prior Art**

There is a known pickup apparatus of a piano having a structure for picking up vibration acceleration of a member which serves as a sound source such as a sound board by adhering a vibration acceleration pickup which converts vibration acceleration into electric signal and outputs the same to a member which serves as the sound source such as the sound board of the piano body.

There has already been proposed to drive a loudspeaker by converting vibration of a sound board in a piano into an electric signal and amplifying the electric signal. For example, as disclosed in specification of U.S. Patent No. 4,058,045, when vibration of the sound board is converted into an electric signal, a pickup comprising a piezoelectric element provided at its opposite surfaces with electrodes is held by holders or housings. One of the holders is brought into contact with the sound board of the piano, and the other one of the holders is connected to a backup plate which serves as a mass provided on an upright of the piano through a spring. A typical acceleration pickup is constituted by the piezoelectric element and the mass. This acceleration

pickup is brought into contact with the sound board of the piano, and piano sound is picked up by picking up the vibration acceleration.

However, it is known that a plate-like vibration plate such as the sound board of the piano body has complicated vibration modes. When such a plate-like vibration plate is vibrating at a certain mode, there exist some points in this plate-like vibration plate at which the vibration acceleration substantially stops and becomes substantially zero, and these points are generally called "nodes".

Further, a point between a node and a node in the plate-like vibration plate at which the vibration acceleration rises to a maximum value is generally called an "antinode". These nodes and antinodes move on the vibration plate by vibration frequency of the vibration plate to form complicated vibration modes.

Therefore, in the case of a pickup of a piano having a structure of picking up the piano sound by picking up the vibration acceleration at a certain point on the sound board of the piano, the point in which the pick up is mounted becomes near to a node or to an antinode of the vibration mode by the frequency at which the sound board vibrates, and the vibration at the point becomes unstable in vibration mode. Therefore, at the frequency at which the point becomes near to a node, the vibration acceleration at that point is small and thus, the output of the pickup is small, and at the frequency at which the point becomes near to an antinode, the vibration acceleration at that point is great. Thus, the output of the pickup is great, and the output of the pickup becomes great or small (increased or decreased) depending upon the frequency of the vibration of the sound board.

For this reason, in the case of the acceleration pickup system, the pickup sound is increased or decreased depending upon the frequency, and it is difficult to output the piano sound with high fidelity.

In the case of a pickup of a piano having a mounting structure in which the acceleration pickup or the like is adhered to the piano using paste, adhesive, double-faced tape, adhesive tape or the like, if the pickup is not adhered completely, there is a problem that tone quality of picked up piano sound is changed or the distortion is included in the sound. Further, if the pickup is adhered to the piano completely and then, the pickup is detached later, varnish or paint on a portion of the piano where the pickup was mounted is peeled off and the piano is damaged. Especially when the piano is made of wood, there is a problem that the wood itself of the piano may be peeled off when the pickup is detached, and the piano is seriously damaged, which is inconvenient.

Further, in a pickup apparatus having a structure in which the acceleration pickup is brought into contact with a sound board of the piano by a spring, a mechanical resonator is constituted by the pickup and the spring. The acceleration of the pickup is liable to be amplified at the resonance frequency and as a result, a peak is generated in the output, and it is difficult to output the piano sound with high fidelity.

Further, in the case of this pick up, the pickup is pushed against the sound board by a force of the spring. Therefore, the distance between the sound board and the upright is largely varied depending upon the kind of piano and mounting piano even if the same piano is used and thus, it is

difficult to adjust the pushing force of the pickup against the sound board to an appropriate value.

For example, if the distance between the sound board and the upright is excessively great, the compression force of the spring, i.e., the pushing force of the pickup against the sound board is insufficient, and when the vibration of the sound board is great, the pickup floats up from the sound board, and undesirable distortion is generated in the sound. To the contrary, if the distance between the sound board and the upright is excessively small, the compression force of the spring, i.e., the pushing force of the pickup against the sound board becomes excessively great, and when the pickup is pushed and mounted between the sound board and the upright, the pickup or the spring is ground against the sound board and the upright with strong force, and the sound board or the upright may therefore be damaged, or the sound board may be excessively deformed, and the piano sound can not be produced with high fidelity.

SUMMARY OF THE INVENTION

One of the objects of the present invention is to provide a pickup apparatus capable of playing piano sound with high fidelity.

Another object of the invention is to provide a pickup apparatus for reliably and correctly picking up piano sound by rigidly connecting a sound source member such as a sound board of a piano body, with a stationary member such as a cast-iron plate with the use of a pickup apparatus body of the invention so as to pickup the generated vibration force.

Another object of the invention is to provide a pickup apparatus capable of easily attaching to or detaching from a piano.

Another object of the invention is to provide a pickup apparatus which is not easily damaged when the pickup apparatus is attached to and detached from a piano.

Another object of the invention is to provide a pickup apparatus having a mechanical vibration filter which eliminates noise components which are unnecessary for piano sound.

According to the present invention, there is provided a pickup apparatus of a piano, comprising: a sensor member having a first contact member which is in contact with a stationary member such as a cast-iron plate of a piano body and a second contact member which is in contact with a sound source member such as a sound board of the piano body; and a length-adjusting mechanism provided on one or both of the first and second contact members, wherein a vibration force applied from the stationary member and the sound source member is converted into an electric signal and output.

By sandwiching the rigid pickup apparatus of the present invention between the sound source member such as a sound board and the stationary member such as a cast-iron plate while applying appropriate preload, the vibration of the sound source member at that point is restrained, a node of the vibration mode whose position is fixed at that point is newly created and at the same time, a force for restraining the vibration is applied to the stationary member through the rigid pickup. Therefore, the vibration force is applied to the pickup, and by converting this vibration force into electric signal and

outputting the same, it is possible to always pickup at the point of the node of the vibration mode, and if the sound board is vibrated at any frequency, it is possible to restrain the increase or decrease of the output of the pickup caused by the vibration mode of the sound board to a minimum value, and it is possible to stably output the piano sound with high fidelity.

Further, by applying appropriate preload between the stationary member and portions contacting with a rib adhered to the sound board, a bridge, a bridge pin provided on the bridge, and a bridge of a string so as to sandwich the rigid pickup apparatus of the present invention, the same effect can be obtained, and it is possible to stably output the piano sound with high fidelity.

The present invention should not be limited to the above-described structure and the working effect obtained therefrom, the invention also includes other structural characteristics and excellent working effect associated with the characteristics, and they fall within the patent claims of the present invention, and they will be made clear in the following embodiments and embodiment claims associated thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a grand piano.

Figure 2 is a vertical sectional view of the grand piano.

Figure 3 is a vertical sectional view of a vertical piano.

Figure 4 is a partially cut-away front explanatory view of a first embodiment.

Figure 5 is a partially cut-away front explanatory view of a second embodiment.

Figure 6 is a partially cut-away front explanatory view of a third embodiment.

Figure 7 is a partially cut-away front explanatory view of a fourth embodiment.

Figure 8 is a partially cut-away front explanatory view of a fifth embodiment.

Figure 9 is a partially cut-away front explanatory view of a sixth embodiment.

Figure 10 is a partially cut-away front explanatory view of a seventh embodiment.

Figure 11 is a partially cut-away front explanatory view of an eighth embodiment.

Figure 12 is a partially cut-away front explanatory view of a ninth embodiment.

Figure 13 is a partially cut-away front explanatory view of a tenth embodiment.

Figure 14 is a partially cut-away front explanatory view of an eleventh embodiment.

Figure 15 is a partially cut-away front explanatory view of a twelfth embodiment.

Figure 16 is a partially cut-away front explanatory view of a thirteenth embodiment.

Figure 17 is a partially cut-away front explanatory view of another structure of the thirteenth embodiment.

Figure 18 is a partially cut-away side explanatory view of Figure17.

Figure 19 is a partially cut-away front explanatory view of a fourteenth embodiment.

DETAILED DESCRIPTION OF THE INVENTION

For explaining embodiments of the present invention, Figures 1 and 2 show a grand piano, and Figure 3 shows a typical vertical piano. Substantially common parts of the grand piano and the vertical piano are represented by the same symbols even if the shapes or mounting places thereof are different.

In the drawings, (A) represents a piano body, (a1) represents a case constituting the piano body (A), (a2) represents a beam member for supporting the case (a1), and (a3) represents various reinforcing members for supporting the beam member (a2).

In addition to the various constituent elements of the piano body (A), (b1) represents a cast-iron plate for stringing strings mounted to the case (a1), and the cast-iron plate (b1) comprises holes (b11) for enhancing transparent sound, and a reinforcing arm (b12).

Further, (b2) represents a pin block for securing ends of the strung strings, and (b3) represents a back post in the vertical piano.

Figures 4 to 7 show embodiments in which a pickup apparatus of the present invention is mounted between the sound board (c1) and the cast-iron plate (b1), and a through hole (b11) of the cast-iron plate (b1) is utilized.

In Figure 4, (D) represents a pickup apparatus body which is placed on the vertically center axis of the through hole (b11). A lower surface of the pickup apparatus body (D) is continuously formed with a second contact member (3). More specifically, the lower surface is formed at its central

portion with a sensor member (1) whose terminal end has a downward projecting spherical body (9). A supporting body (1) is placed and fixed on the sound board (c1) immediately below the spherical body (9), and the spherical body is fitted to the supporting body (10). As a result, the pickup apparatus body (D) acts as an angle adjusting mechanism (5) capable of freely swinging in the horizontal direction around this supporting point as a fulcrum.

An upper portion of the pickup apparatus body (D) is threaded into a long screw (11), and the long screw (11) threadedly passes through a center portion of a horizontal main arm (12) having a diameter smaller than that of the through hole (b11). Reference numeral (13) represents a plurality of sub-arms whose inner ends are screwed (14) to the outer sides of the main arm (12) and disposed in the radial directions. The outer ends of the sub-arms (13) are in contact with a back surface of the cast-iron plate (b1) located outside of the through hole (b11) through contact members (15).

Reference numeral (16) represents a rotation knob fixed to an upper end of the sensor member (1), and (17) represents an output connector whose terminal end is electrically connected to the sensor member (1).

If the rotation knob (16) is rotated, the long screw (11) is associatively rotated to rise the main arm (12). As a result, the sub-arms (13) push up the back surface of the cast-iron plate (b1) through the contact members (15). That is, the sensor member (1) is allowed to be interposed between the sound board (c1) and the cast-iron plate (b1) through the supporting body (10) and the sub-arms (13), respectively, and the vibration of the sound board (c1) is introduced through the supporting body (10) and the spherical body (9) and converted into a signal, and output from the output connector (17).

That is, the rotation knob (16) is rotated leftward as viewed in the drawings so that the sensor member (1) brought into a state in which the sensor member (1) approaches the main arm (12) closest. Next, the two sub-arms (13) mounted to the opposite ends of the main arm (12) are folded so that the tip ends of the sub-arms (13) come closest to the main arm (12). The entire pickup apparatus body (D) is inserted to the hole (b11) of the cast-iron plate (b1), the contact member of the sound board (c1) of the pickup apparatus body (D) is brought into contact with the sound board, and all of the sub-arms (13) are moved such that the contact members (15) are placed between the cast-iron plate (b1) and the sound board (c1). Then, the rotation knob (16) is rotated rightward so that the contact members (15) are brought into contact with the back surface of the cast-iron plate (b1), and the pickup apparatus body (D) is sandwiched between the cast-iron plate (b1) and the sound board with appropriate force. Then, an output cable (not shown) is connected to the output connector (17), and the mounting operation is completed.

Here, sound quality of the sound output from the pickup is checked by hearing the same, and the sandwiching force of the pickup is adjusted if necessary. By carrying out the above-described procedure in the reverse order, it is possible to easily mount and demount the pickup apparatus body (D).

Next, an embodiment shown in Figure 5 will be explained while representing the same parts with the same symbols as those in the previous embodiment. The main arm (12) is on the vertically central axis of the through hole (b11) in the cast-iron plate (b1), and the main arm (12) is horizontally placed above the through hole (b11). Upper ends of J-shaped and reversed J-shaped sub-arms (18) are pivotally mounted to the opposite ends of

the main arm (12), and other ends of the sub-arms (18) are located outside of the through hole (b11) and in contact with the back surface of the cast-iron plate (b1).

The rotation knob (16) is rotated in the same manner as that of the previous embodiment, so that the sensor member (1) is allowed to be tightly interposed between the sound board (c1) and the cast-iron plate (b1).

Figures 6 and 7 show modifications of the above-described main arm (12). That is, the main arm (12) shown in Figure 6 is formed into a horizontal convex shape. The long screw (11) threadedly passes through a central portion of the main arm (12), and opposite shoulder portions (19) are located outside a through hole (c11) and in contact with the back surface of the cast-iron plate (b1).

If the sensor member (1) or the main arm (12) is rotated, the sensor member (1) is allowed to tightly be interposed between the sound board (c1) the cast-iron plate (b1). Figures 6 to 9 showing this embodiment, and in Figures 10 to 19 showing other embodiments show a case in which the output connector (17) of an electric output connector member (6) is directed mounted to the sensor member (1).

The pickup apparatus body (D) having a first contact member (2) and a second contact member (3) is provided with a length adjusting mechanism (4), and the pickup apparatus body (D) is sandwiched in a gap between the cast-iron plate (b1) which is a stationary member (b) and the sound board (c1) which is the sound source member (C) and thus, the pickup apparatus body

(D) is provided with a function as the angle adjusting mechanism (5) which can adjust the contacting angle of the cast-iron plate (b1).

Further, since the cast-iron plate (b1) is extremely hard, even if it is brought into contact with the first contact member (2), the cast-iron plate (b1) is not deformed or a contacting trace should not be remained. However, if the stationary member (C) is made of wood, the contacting trace may remain in such a wood and therefore, it is important to select appropriate embodiments which will be described later.

In an embodiment shown in Figure 7, a member corresponding to the above-described main arm (12) is a flat horizontal metal plate. (20) represents a pair of L-shaped sub-arms, a vertical portion of each of the sub-arms (20) is formed with a single or a plurality of through grooves (21), and opposite ends of the main arm (12) are fitted in the through grooves (21).

Horizontal upper surfaces of the sub-arms (20) are in contact with the back surface of the cast-iron plate (b1). If the sensor member (1), the long screw (11), or the main arm (12) is rotated, the pickup apparatus body (D) is allowed to be tightly interposed between the sound board (c1) and the cast-iron plate (b1).

In the above embodiment, the through hole (b11) of the cast-iron plate (b1) is utilized. Off course, the through hole (b11) may not be utilized, and Figure 8 and subsequent drawings show such an example.

That is, in Figure 8, (22) represents a nut-like rotation base which is threadedly engaged with the long screw (11), and by rotating the base (22),

the pickup apparatus body (D) having the sensor member (1) can be allowed to be tightly interposed between sound board (c1) and the cast-iron plate (b1).

In any of the above embodiments, the supporting body (10) is placed on the sound board (c1), and the spherical body (9) of the sensor member (1) is fitted to the supporting body (10). As described above, this is the angle adjusting mechanism (5) of the piano contacting surface angle. This mechanism may not be provided off course.

That is, in Figure 9, the long screw (11) in the embodiment shown in Figure 8 is threadedly engaged with the base (22), the base (22) is brought into contact with and fixed to the sound board (c1) such that a spherical projecting portion (23) abuts against the back surface of the cast-iron plate (b1) from the central portion of the upper surface of the sensor member (1), and by rotating the long screw (11), the pickup apparatus body (D) having the sound board (c1) can be allowed to be tightly interposed between the sound board (c1) and the cast-iron plate (b1).

Figure 10 shows an example of a viscoelastic member (7) (mechanical vibration filter) which eliminates vibration of noise portions (vibration transmitted from a floor, vibration generated when a pedal of a pedal is operated and the like) which is unnecessary for piano sound coming from a portion which is not vibrated (stationary member (B) or the like) to the pickup apparatus body (D) of the present invention.

That is, a mass (24) and a viscoelastic body (25) are placed on the base (22) of the fifth embodiment (Figure 8) explained above, and this is engaged with the back surface of the cast-iron plate (b1).

In this case, the viscoelastic body (25) has both spring characteristics and viscous characteristics, and if the viscoelastic body (25) is pushed slowly, this acts as a spring (at low frequency), and if the viscoelastic body (25) is pushed quickly, this becomes a hard solid object (at high frequency). To be precise, the viscoelastic body (25) exhibits viscous drag. By sandwiching the viscoelastic body (25) between the cast-iron plate (b1) and the mass (24), vibration force of low frequency is absorbed by the spring characteristics and the mass (24) and is not allowed to pass through, and vibration of high frequency passes through because the viscoelastic body (25) is hard and thus, the vibration force of high frequency is introduced to the sensor member (1). With this effect, noise component of low frequency is not pickup.

An embodiment shown in Figure 11 is an example in which the angle adjusting mechanism (5) of the previous embodiment is unnecessary and in this case, the sensor member (1) is placed directly on the upper surface of the sound board (c1).

In any of embodiments shown in Figures 12 to 15, the pickup apparatus body (D) of the present invention is provided such as to be in contact with a ponticello (c3) of a string of a bridge (c5) provided on the sound board (c1).

In Figure 12, the pickup apparatus body (D) has the same structure as that of the fifth embodiment (Figure 8). In this case, the supporting body (10) is in contact with an upper surface of the bridge through the string (c5), and the base (22) is in contact with a lower surface of the arm (b12) of the cast-iron plate (b1).

Figures 13 and 14 show examples in which the above-described mounting member (8) is provided.

That is, in Figure 13, a vise-like mounting member (8) exclusive to this embodiment is provided such as to sandwich the arm (b12) of the cast-iron plate (b1), and the first contact member (2) of the pickup apparatus body (D) of the present invention is abutted against the mounting member (8).

That is, this mounting member (8) may not be provided in single, but several kinds of members may be combined. Figure 14 shows a structure in which the mounting member (8) comprises a member (26) having U-shape cross section and an L-shaped member (27) provided along a vertical outer surface of the U-shaped member (26), the U-shaped member (26) fixes the arm (b12) of the cast-iron plate by a screw (28), and the L-shaped member (27) is fixed to an appropriate position of the U-shaped member (26) by the screw (28), and the L-shaped member (27) is threadedly engaged with the long screw (11) of the pickup apparatus body (D).

Figure 15 shows a structure corresponding to that of the third embodiment (Figure 6) except that the position where the piano body is mounted is changed. That is, the arms (b12) of the cast-iron plate (b1) have portions which are opposed to each other at a constant distance, and when the piano body is placed in such portions, it may be disposed such that the lower surfaces of the arms (b12) are in contact with both the shoulder portions (19) of the main arm (12). The pickup apparatus body (D) of the present invention can be placed on any place only if it is interposed between the stationary member (B) and the sound source member (C) of the piano body (A).

That is, in Figure 16, the pickup apparatus body (D) is provided between a brace (b4) of the piano body (A) and the sound board (C), and in Figures 17 and 18, the pickup apparatus body (D) is provided between the brace (b4) and a rib (c2) adhered to the sound board (c1).

In Figure 19, the pickup apparatus body (D) is provided between the case body (a1) constituting the piano body and the sound board (c1), and its structure is the same as that of the fifth embodiment (Figure 8).

Although the present invention has been fully described in connection with the preferred embodiment thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications will be apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims, unless they depart therefrom.

EXPLANATION OF SYMBOLS

A	piano body
a1	case
a2	beam member
a3	various reinforcing member
B	stationary member
b1	cast-iron plate
b11	hole
b12	arm
b2	pin block
b3	back post (vertical piano)
b4	brace
b5	inner rim
b6	outer rim
C	sound member
c1	sound board
c2	rim
c3	bridge
c4	bridge pin
c5	string
D	pickup apparatus body
1	sensor member
2	first contact member
3	second contact member
4	length adjusting mechanism
5	angle adjusting mechanism
6	electric output connector member
7	viscoelastic member

8	mounting member
9	spherical body
10	supporting body
11	long screw
12	main arm
13	sub-arm
14	screwed
15	contact member
16	rotation knob
17	output connector
18	J-shaped sub-arm
19	opposite shoulder portions
20	L-shaped sub-arm
21	through groove
22	base
23	spherical projecting portion
24	mass
25	viscoelastic member
26	U-shaped member
27	L-shaped member
28	screw